(12) UK Patent Application (19) GB (11) 2 267 921 (13) A

(43) Date of A publication 22.12.1993

(21) Application No 9213072.3

(22) Date of filing 19.06.1992

(71) Applicant
David Brankling
5 Spring Tyne, Westhill, Skene, Aberdeenshire, AB32 6NH, United Kingdom

(72) Inventor
David Brankling

(74) Agent and/or Address for Service
Oilfield Chemical Technology Limited
Wood International Centre, Craigshaw Drive, West Tullos, Aberdeen, AB1 4AG, United Kingdom

(51) INT CL[5]
C09K 7/02

(52) UK CL (Edition L)
E1F FGP

(56) Documents cited
US 4792412 A

(58) Field of search
UK CL (Edition L) E1F FGP
INT CL[5] C09K
On-line data base WPI

(54) Drilling fluid

(57) An aqueous based drilling fluid containing a homopolymer of polyvinyl pyrollidone, the latter acting as a shale inhibitor.

GB 2 267 921 A

2267921

DRAFT

DRILLING FLUID POLYMER COMPOSITION

This invention relates to the use of polyvinyl pyrollidone as a shale inhibitor for aqueous based drilling fluids.

One major problem which can occur when water based fluids are used as drilling muds is reaction with rock containing clay minerals (shales) which leads to hydration of the rock and subsequent hole stability problems.

Adsorption of water to the wellbore rock leads to swelling with resultant stresses and failure such as wellbore expansion, stuck pipe, excessive rheology and general drilling problems.

In order to prevent these difficulties aqueous based fluids are formulated with a variety of salts and polymers which reduce the tendency for water to hydrate the rock and may encapsulate drilled solids to prevent disintegration.

A second alternative is to avoid the use of water based drilling fluids and drill with oil based muds.

However, oil based mud is expensive and is increasingly becoming unacceptable on environmental grounds.

Water based drilling fluids contain a wide variety of salt components at varying concentration to reduce shale hydration.

These include sodium, potassium and calcium chlorides, potassium carbonate, sodium acetate, calcium sulphate and other materials known to those in the industry.

Although such additives provide a degree of inhibition it is normally required to include a polymeric species to provide further beneficial properties.

These may include carboxylated celluloses, polyacrylamide and derivatives, sulfonated co-polymers, xanthan gums, hydroxyethyl cellulose, starch and other water soluble colloids.

The polymers may be designed to adsorb strongly at the rock surfaces, acting as protective colloids to reduce water adsorption and prevent hydration.

Typical products would include partially hydrolysed polyacrylamide (PHPA), carboxymethyl cellulose (CMC) or polyanionic cellulose (PAC).

In all cases these polymers are of an anionic nature to provide a charged molecule which will adsorb to the rock surface.

Cont.../...

Similar anionic polymers are used as fluid loss additives to control the filtration characteristics of the drilling fluid.

In order to minimise fluid invasion to the porous drilled rocks and hence lower losses of fluid during drilling, fluid loss additives are an essential component of the drilling mud.

Components include CMC, PAC as above, sulphonated polymers, starch and other colloidal products.

However, to ensure good performance at high temperature the polyanionic substituted materials such as CMC, PAC and sulphonates are commonly used.

The combination of salts, fluid loss polymer additive and shale inhibiting polymer therefore provides the basis for an inhibitive drilling mud.

Other components may include viscosifiers such as clay, xanthan gum, HEC polymer to provide suitable rheology, weighting materials such as barytes or haemetite designed to adjust the fluid density and minor components such as dispersants, biocides, lubricants to provide a complete mud package.

However, it has been found that in highly reactive formations, that is rocks containing large amounts of hydrateable clay, the above systems only provide partial inhibition of shale hydration.

Performance is therefore not adequate to meet the requirements of reactive drilling in sections where oil mud would be used.

An improvement in the performance of water based mud has been seen with the introduction of cationic mud systems.

In such fluids cationic polymers are used to replace conventional anionic polymers with the result that much stronger adsorption to the shale surface takes place and inhibition is improved.

Products include cationic starch, cationic polyacrylamide, polyamines and other water soluble materials.

However, such systems have a number of problems which limits their use:

i. The cationic polymers used are not compatible with conventional anionic polymers such as fluid loss additives. A complete mud system rather than a simple additive therefore requires production.

ii. Many of the cationic polymers have biocidal and toxicity problems related to their strong adsorption to proteinaceous surfaces which is of concern for offshore use.

iii. The need to supply viscosifier, fluid loss additive and encapsulating polymer on the basis of compatibility with each other results in very expensive fluids.

Cont.../...

It would be desirable if a polymer could be introduced to a conventional mud system which had the properties of cationic polymers, that is strong adsorption to shale, but was non-toxic and compatible with anionic polymers.

This is the basis of the current invention.

We have found that homopolymers of polyvinyl pyrollidone possess the necessary cationic character to adsorb strongly to shales and provide inhibition in water based fluids but are fully compatible with conventional mud polymers and from the recorded literature are non-toxic.

Their usefulness may be illustrated in the following tests:

1. Inhibition of Shale Hydration

The polyvinyl pyrollidone polymers used in this work are produced by GAF Chemicals as PVP K-15, PVP K-30, PVP K-60 and PVP K-90 where increasing numbers relate to increasing molecular weight.

The pyrollidone group consists of a ring containing nitrogen which confers the slight cationic properties to the molecule.

A simple shale test to screen the performance of potential additives involves the storage of particles of Wyoming bentonite - a highly reactive clay, in the test fluid for a given time and examination of hydration tendencies.

The test comprises sieving natural ore to a particle size of 1-2 mm, storage of 5 g of this with 45 g of test fluid at 80 - 95°C for 24 hours after which the sample is resieved to recover ore of +1 mm size.

Reacted shale breaks to a fine powder which is not recovered from the test.

Inhibition is then ranked on the basis of % shale recovered as +1 mm particles.

System	% Shale Recovery
Sea water	17
0.2% PVP K-15 in sea water	36
0.2% PVP K-30 in sea water	42
0.2% PVP K-60 in sea water	78
0.2% PVP K-90 in sea water	95
0.6% PHPA in sea water	66
0.3% PAC in sea water	40

PHPA is a conventional polyacrylamide shale inhibitor. PAC is a conventional polymer shale inhibitor and fluid loss additive.

The ability of polyvinyl pyrollidone to effectively prevent shale hydration in comparison to standard polymers and the improvement as molecular weight increase is clearly seen.

Cont.../...

2. Compatibility With Anionic Polymers

Taking a simple system of sea water containing 4.2% pre-hydrated bentonite as viscosifier the compatibility of PVP K-90 with a conventional fluid loss additive is demonstrable.

a. Base Mud : 4.2% pre-hydrated bentonite in sea water plus 0.17% PVP K-90

Rheologies:	Apparent Viscosity	37 cP
	Plastic Viscosity	19 cP
	Yield Point	17 Pa
Fluid loss:	API method	70 mls

b. Base Mud + 0.3% Staflo Exlo polyanionic cellulose fluid loss reducer:

Rheologies:	Apparent Viscosity	37 cP
	Plastic Viscosity	21 cP
	Yield Point	15 Pa
Fluid loss:	API method	11.5 mls

c. Mud b. at 100°C for 16 hours:

Rheologies:	Apparent Viscosity	27 cP
	Plastic Viscosity	17 cP
	Yield Point	10 Pa
Fluid loss:	API method	13 mls

In combination with a conventional fluid loss additive PVP K-90 therefore maintains compatibility and is stable to temperature.

3. Whole Mud Properties

The ability of PVP K-90 to enhance basic fluid properties is given in the following series of tests using a simple sea water mud.

Formulation:	0.4%	Staflo R (PAC viscosifier and fluid loss additive)
	0.4%	XC polymer (Xanthan viscosifier)
	1.4%	Drilled solids (OCMA base clay)
		Sea water
		pH 9.3

Fluid made to the above formulation with and without the addition of 0.17% PVP K-90, rheology and fluid loss determined before and after 16 hours rolling at 95°C. Shale stability tests conducted according to the procedure in 1. above on fluid before and after thermal ageing (BHR, AHR).

Cont.../...

Mud properties:

	Base Mud		+PVP K-90	
	BHR	AHR	BHR	AHR
AV/cP	40.5	31.5	38.5	26.5
PV/cP	21	17	19	15
YP/Pa	19	14	19	11
API fluid loss/ml	9.0	13.5	8.5	7.6
Shale recovery %	74	34	97	61

Mud properties remain good with a significant improvement in shale recovery.

Polyvinyl pyrollidone therefore has the ability to considerably improve the shale inhibiting properties of aqueous based mud systems but allows the continued use of conventional anionic fluid loss additives.

Cont.../...

CLAIMS

What is claimed is:

1. A drilling fluid system containing a homopolymer of polyvinyl pyrollidone (PVP) used as a shale inhibiting additive.

2. A drilling fluid system according to Claim 1 in which the PVP is present at concentrations of 0.01% to 5.0% by weight.

3. A drilling fluid system according to Claims 1 and 2 in which the PVP molecular weight may vary from 5000 to 10,000,000 but is preferably greater than 1,000,000.

4. A drilling fluid according to Claims 1-3 which may include an anionic polymeric viscosifier.

5. A drilling fluid according to Claims 1-4 which may include an anionic polymeric fluid loss additive.

6. A drilling fluid according to Claims 1-5 which may contain polymeric viscosifiers.

7. A drilling fluid according to Claims 1-6 which may contain a weighting agent such as barite.

8. A drilling fluid according to Claims 1-7 in which there may be present soluble salts dissolved in the aqueous phase.

9. A drilling fluid according to Claims 1-8 which may contain clay as a gelling aid.

10. A drilling fluid according to Claims 1-9 in which may be present other treatment additives to control mud stability.

11. A drilling fluid according to Claims 1-10 which is substantially inhibitive to shale.

12. A drilling fluid according to Claims 1-11 which may be used to drill and complete wells at onshore and offshore sites.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

GB 9213072.3

Relevant Technical fields

(i) UK Cl (Edition L) E1F (FGP)

(ii) Int Cl (Edition 5) C09K

Search Examiner

D B PEPPER

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search

24 MARCH 1993

Documents considered relevant following a search in respect of claims 1 TO 12

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	US 4792412 (HEILWEIL) Note column 2, lines 41-68	1-12

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

Published 1993 at The Patent Office, Concept House, Cardiff Road, Newport, Gwent NP9 1RH. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.